# LABORATORY TESTING FOR SUITABLE MATERIALS

# KAOPA SUBDIVISION STORM WATER STORAGE BASIN

# KAILUA, OAHU, HAWAII

# TMK: 4-2-04: 1

# for

# HAWAIIAN PACIFIC INDUSTRIES, INC.



June 12, 1972

W.O. 139

ERNEST K. HIRATA & ASSOCIATES, INC.

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June 12, 1972
W.O. 139

Hawaiian Pacific Industries, Inc.
1020-E Keolu Drive
Kailua, Oahu, Hawaii 96734

Attention: Mr. William Rus

Subject: Laboratory Testing for Suitable Materials
Kaopa Subdivision Storm Water Storage Basin
Kailua, Oahu, Hawaii
TMK: 4-2-04: 1

Gentlemen:

As requested, we have completed investigation and laboratory testing for suitable materials to be used in the Kaopa Subdivision Storm Water Storage Basin project, and the following presents the results and conclusions of our testing.

## SCOPE OF INVESTIGATION

The "Special Provisions for Kaopa Subdivision Stormwater Storage Basin and Outflow Channel" by Mr. Y. Arakaki dated February 14, 1972 was used as a guide in determining the acceptability of the materials tested.

Three categories of materials are called for in the construction of the earth dam. The first category called "impervious material" will be used primarily for the core section of the dam. The second category called "semipervious material" will be used in the upstream section of the embankment. The third

category called "pervious material" will be used in the downstream section of the embankment.

Samples for the proposed embankment were gathered from existing and proposed subdivisions surrounding the area. Materials from four areas were found to be suitable for use in the construction of the earth dam.

## LABORATORY TESTING

Materials were tested for their gradational size, maximum dry density, Atterburg Limits, and remolded shear strength characteristics of internal friction value and cohesion.

Gradational size was determined by the sieve analysis method, while the maximum dry density was determined in accordance with the Modified AASHO Test T-180. Laboratory classification was determined by the Atterburg Limit Tests according to ASTM D423 and D424.

Shear tests were performed in the Direct Shear Machine which is of the strain control type. The rate of deformation was approximately 0.03 inches per minute. Each sample is sheared under varying confining loads in order to determine the Coulomb shear strength parameters, cohesion and angle of internal friction. Eighty percent of the ultimate value is taken to determine the shear strength parameters.

## CONCLUSIONS AND RECOMMENDATIONS

### A. Impervious Materials

Impervious materials were obtained from Enchanted Lakes Estates Subdivision Kaopa Unit 3 and from the Dam Site itself. Materials from each site were mixed together and tested for their strength characteristics.

We find that it is impossible to have a material with the gradation given in the special provisions to have a minimum dry density of 130 pounds per cubic foot. Past experiences indicate that clays, considered as impervious materials, generally have a dry density in the range of 90 to 110 pounds per cubic foot.

We therefore recommend that the special provisions be revised to allow for a dry density range of 95 to 105 pounds per cubic foot. Likewise the Liquid Limit for cohesive clays generally are above 50, and we recommend a raising of the maximum allowable to 60.

Direct shear tests run on a remolded sample at 90 percent compaction indicate an internal friction angle of $55^{o}$ with a cohesion of 2.28 KSF. Results obtained are above the minimum requirements as called for in the special provisions.

B. Semipervious Materials

Semipervious materials were obtained from Kailua Heights Unit 6B which is currently being graded, and from Kailua Heights Unit 8 which is in the preliminary planning stages.

Both materials tested were within gradation limits. The dry densities ranged between 118.0 and 128.0 pounds per cubic foot. These values are within the required ranges as given in the special provisions.

Direct shear tests conducted on remolded samples at 90 percent compaction indicate internal friction angles of 44° and 58° with cohesion values of 2.66 and 1.39 KSF.

C. Pervious Materials

Pervious materials may be obtained from the same sites as the semipervious materials. However to meet gradational requirements, we recommend that #3 Coarse B select material having the following gradation be added to the semipervious materials in order to be acceptable as pervious materials.

| Sieve Size | % Passing |
|---|---|
| 1½" | 100 |
| 1" | 70 - 90 |
| 3/4" | 35 - 50 |
| ½" | 3 - 7 |
| 3/8" | 0 - 3 |

The #3 Coarse B material can be obtained from rock quarries of concrete companies.

We recommend that for pervious materials, the dry density range be between 115 and 125 pounds per cubic foot. This density requirement will allow sufficient permeability and dissaption of residual pore pressure while also helping to support and stabilize the core portion.

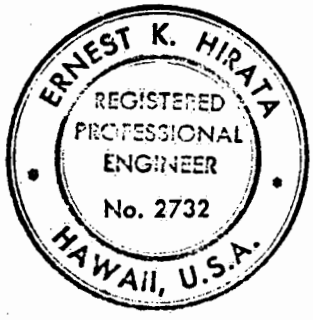
Respectfully submitted,

Ernest K. Hirata & Associates, Inc.

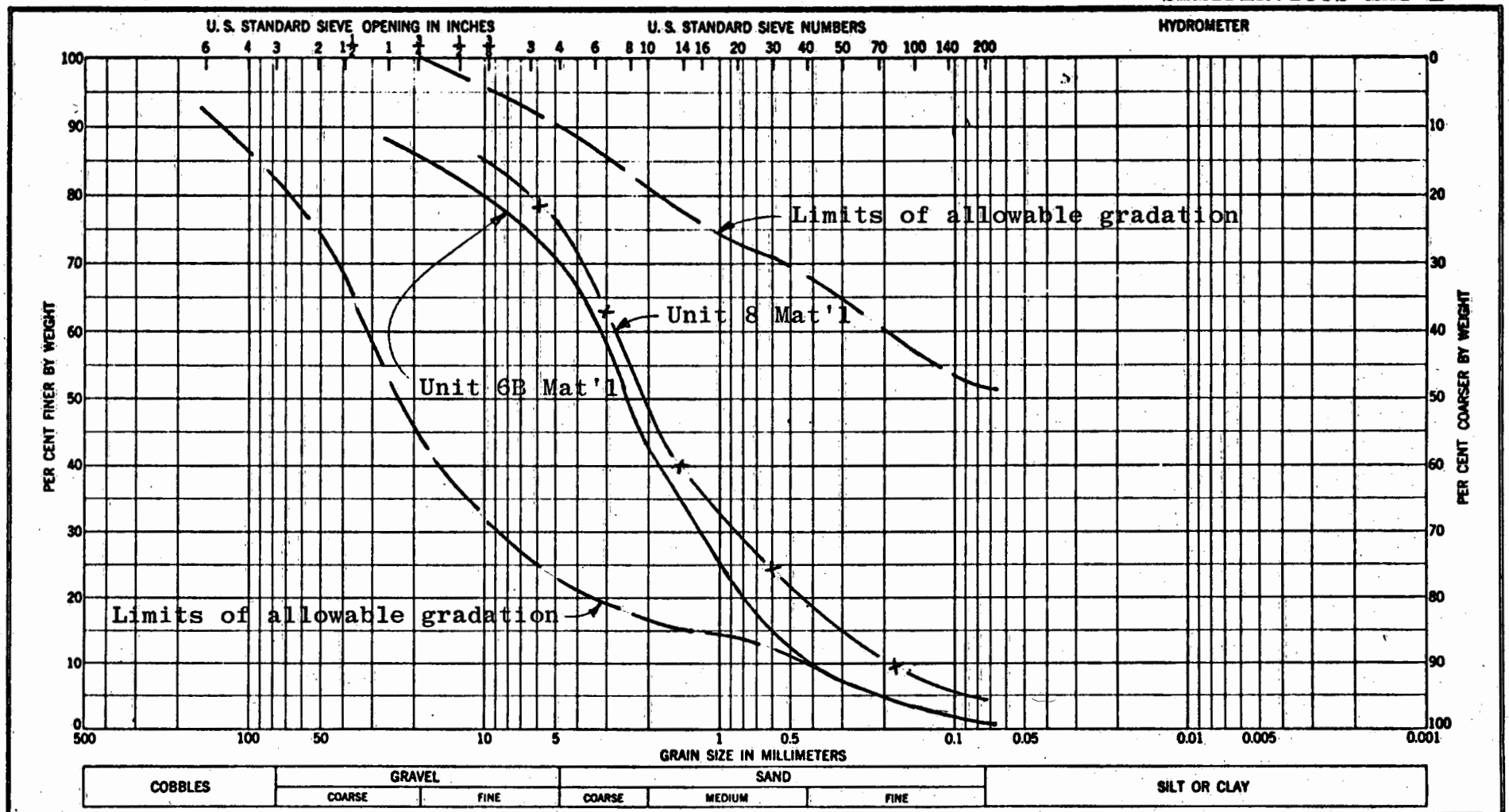
Ernest K. Hirata

Ernest K. Hirata P.E. 2732

Enc: Gradation Curves Plates A1 through A3
Maximum Density Curves Plates B1 through B3
Shear Test Diagrams Plates C1 through C3



SEMIPERVIOUS MAT'L




| Sample No. | Elev or Depth | Classification | Nat w % | LL | PL | PI |
|---|---|---|---|---|---|---|
| Rocky Material from | | Unit 6B ML | | 36.5 | 31.2 | 5.3 |
| Rocky Material from | | Unit 8 ML | | 37.7 | 25.7 | 12.0 |
| | | | | | | |
| | | | | | | |
| | | | | | | |

GRADATION CURVES

Project: Kaopa Storm Water Storage Basin - Dam Site
Area: W.O. 139
Boring No.: Rocky Material from Unit 6B and Unit 8
Date: 4-20-72

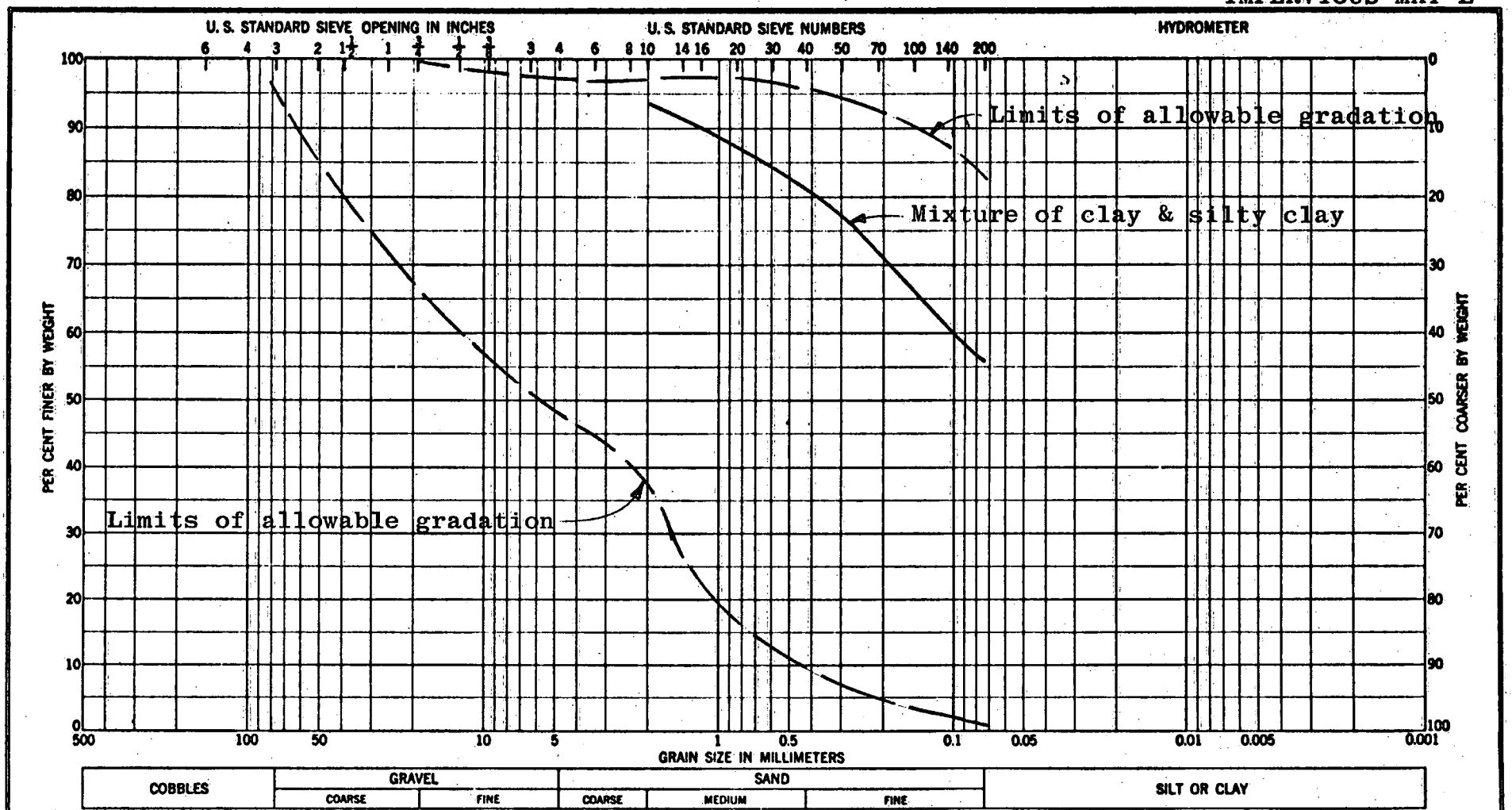
ENG FORM 2087 1 MAY 63 REPLACES WES FORM NO. 1241, SEP 1962, WHICH IS OBSOLETE. (TRANSLUCENT)

C 3438

Plate A1

Plate A1

IMPERVIOUS MAT'L




| Sample No. | Elev or Depth | Classification | Nat w % | LL | PL | PI |
|---|---|---|---|---|---|---|
| Dam Site | Material | MH | | 51.7 | 36.5 | 15.2 |
| Kaopa #3 | Material | ML | | 47.2 | 33.9 | 13.3 |
| | | | | | | |
| | | | | | | |
| | | | | | | |

GRADATION CURVES

Project Kaopa Storm Water Storage Basin - Dam Site

Area W.O. 139

XXXXX Mixture of clay & silty clay

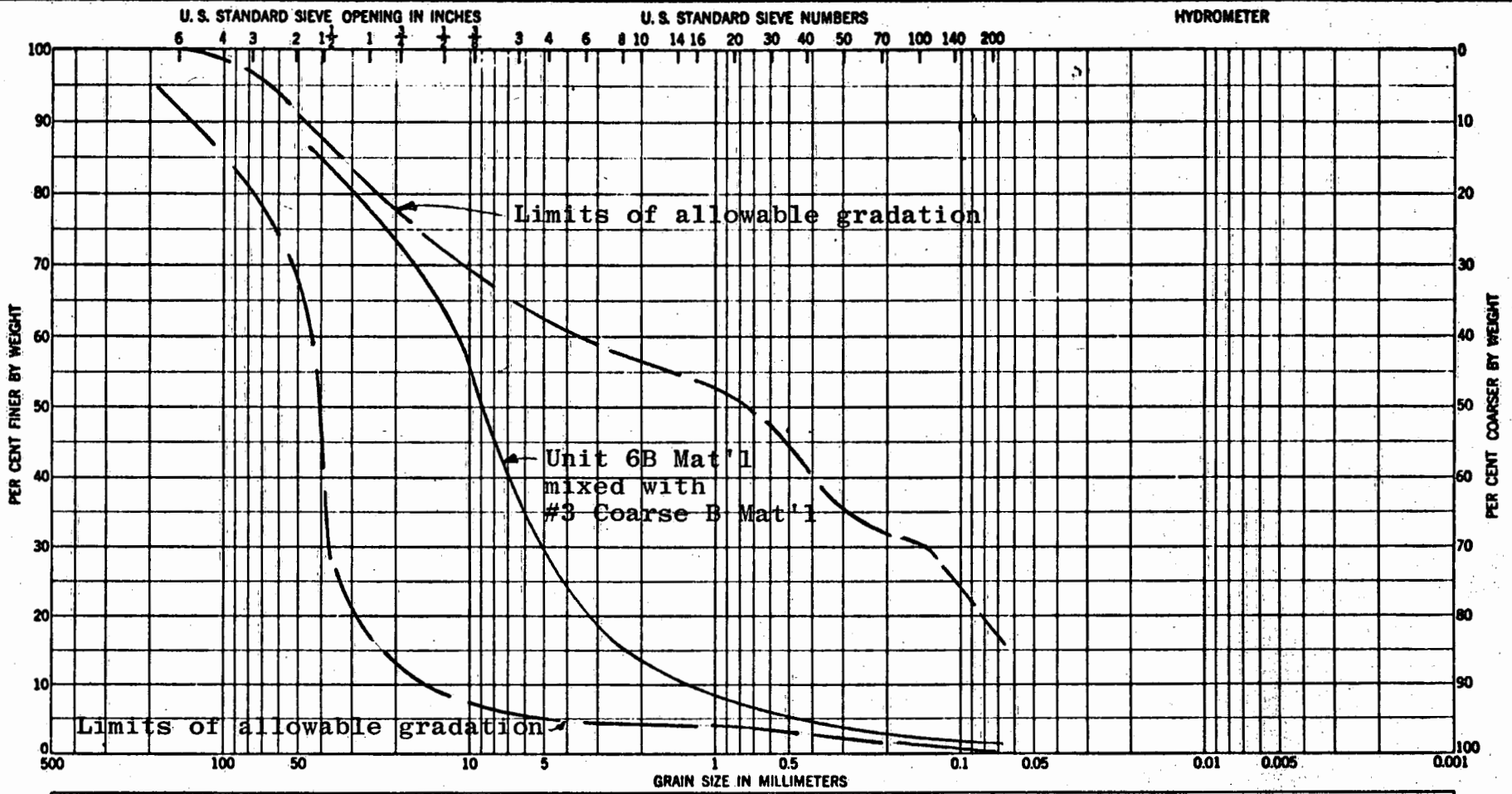
Date 6-3-72

Plate A2

ENG FORM 2087 1 MAY 63 REPLACES WES FORM NO. 1241, SEP 1962, WHICH IS OBSOLETE. (TRANSLUCENT)

C 3438

PERVIOUS MAT'L




| Sample No. | Elev or Depth | Classification | Nat w % | LL | PL | PI |
|---|---|---|---|---|---|---|
| Rocky Material from Unit 6B | | | | | | |
| #3 Coarse B Material | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |

GRADATION CURVES

Project Kaopa Storm Water Storage Basin - Dam Site

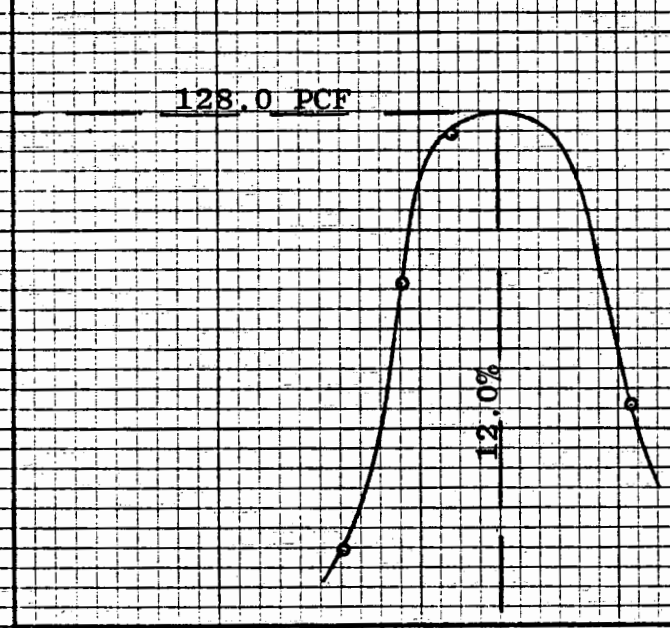
Area W.O. 139

Boring No. Rocky Material from 6B mixed with #3 Coarse B

Date 6-3-72

Plate A3

MAXIMUM DENSITY CURVE



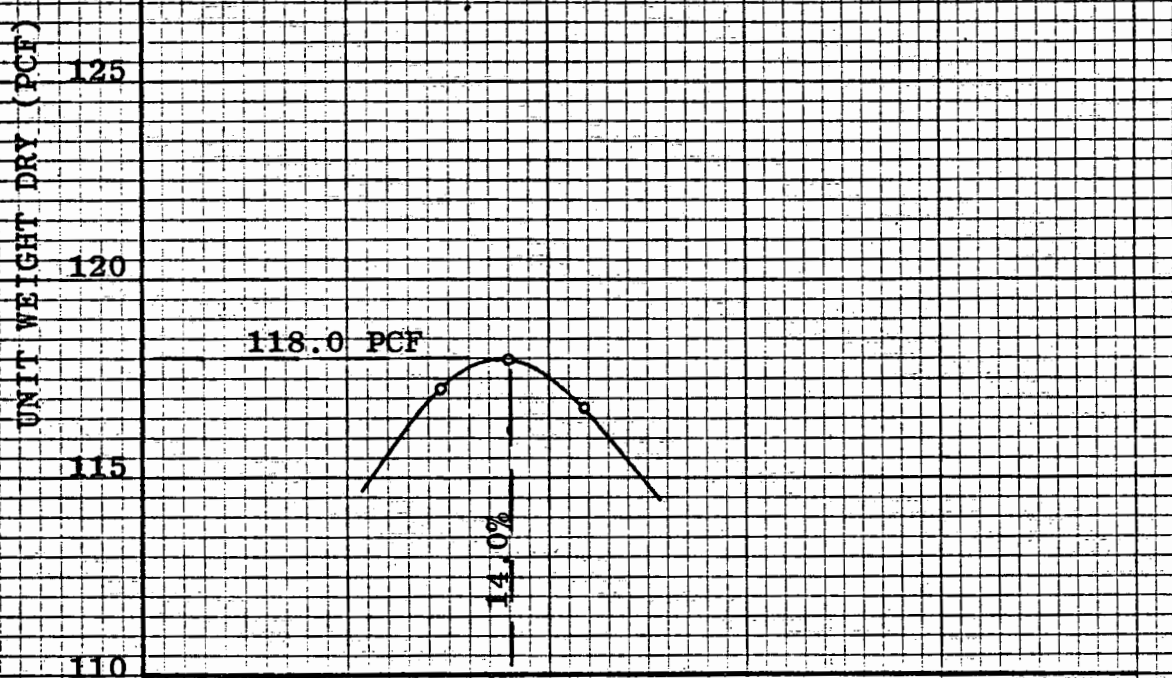

Boring:

Depth: Surface

Classification: ML W.O. 139
Rocky Material
from Unit 6B

L.L.= 36.5
P.L.= 31.2
P.I.= 5.3

MAXIMUM DENSITY CURVE




Boring:

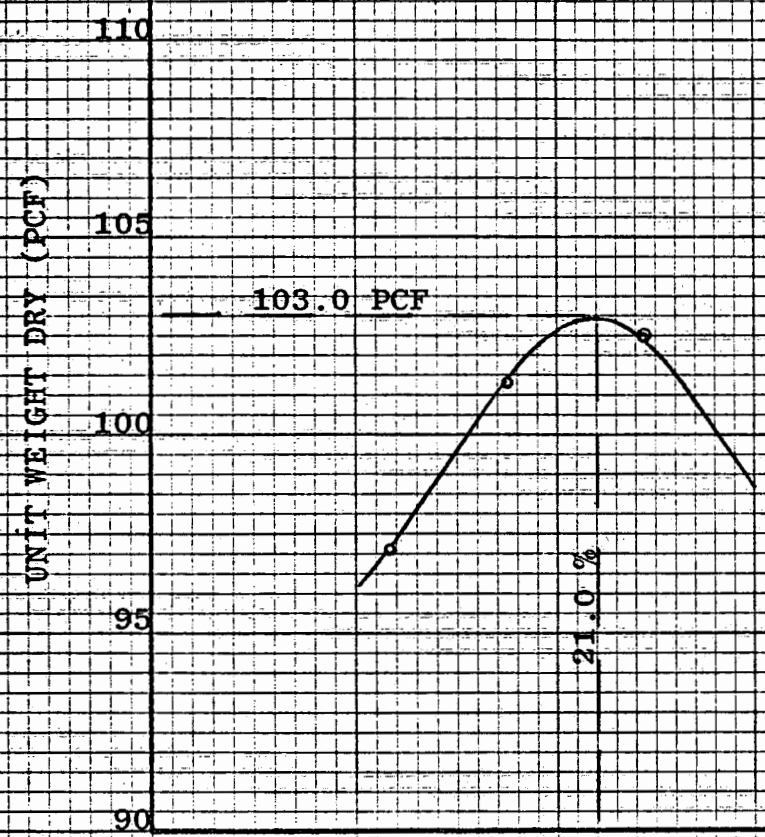
Depth: Surface

Classification: ML W.O. 139

Rocky Material
from Unit 8

LL=37.7
PL=25.7
PI=12.0

MAXIMUM DENSITY CURVE




Boring:

Depth:

Classification: MH-ML W.O. 139

Dredged material from Kaopa #3 mixed with the dam site material

| Dam Site | Kaopa #3 |
|---|---|
| LL=51.7 | LL=47.2 |
| PL=36.5 | PL=33.9 |
| PI=15.2 | PI=13.3 |

Plate B3

# ERNEST K. HIRATA & ASSOC.

Date 4-28-72

Job Kaopa Storm Water Storage Basin W.O. 139

REMOLDED
Rocky material
from Unit 6B

## SHEAR TEST DIAGRAM

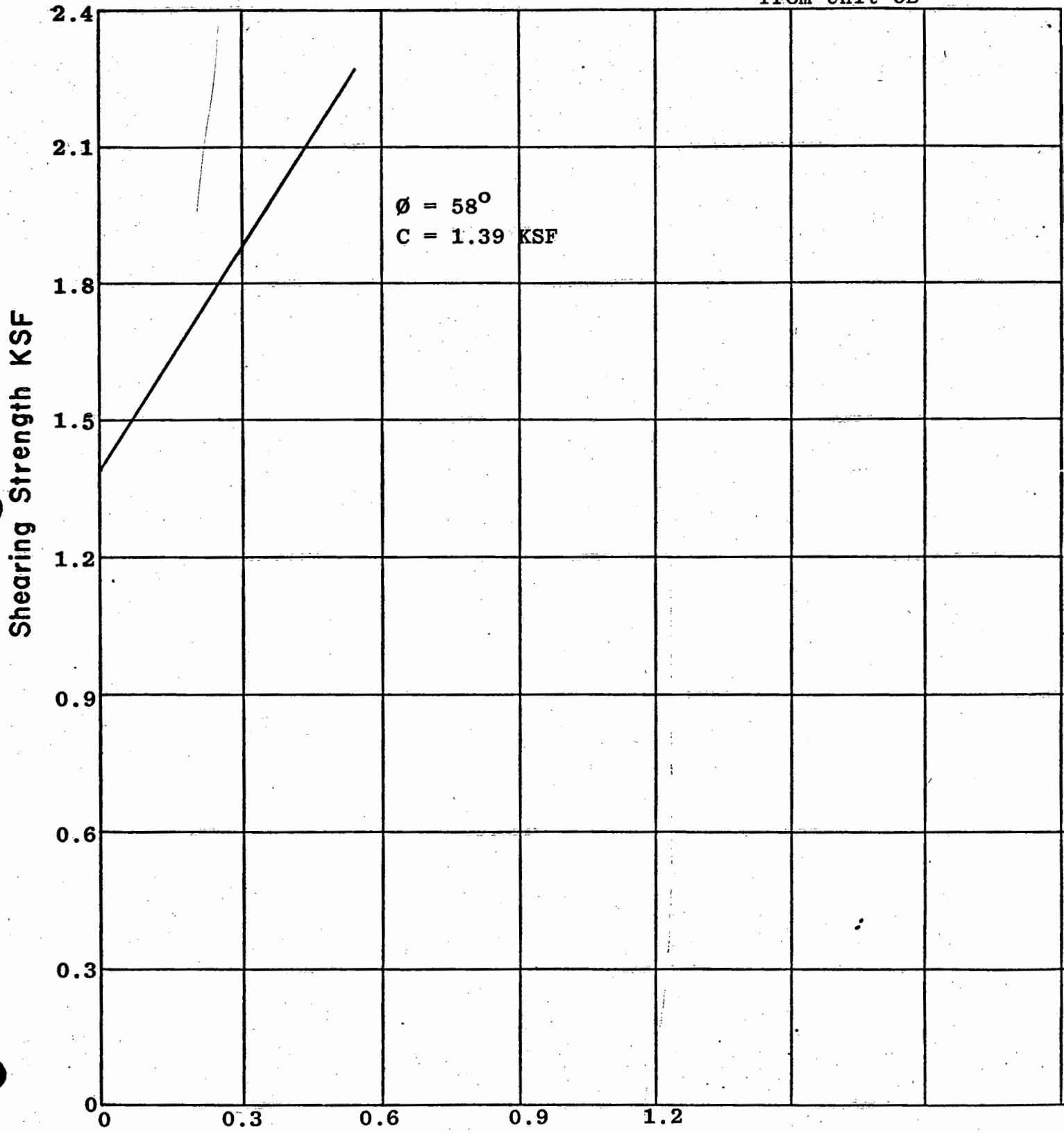



Plate C1

# ERNEST K. HIRATA & ASSOC.

Date 6-8-72

Job Kaopa Storm Water Storage Basin W.O. 139

## SHEAR TEST DIAGRAM

REMOLDED
Rocky material
from Unit 8

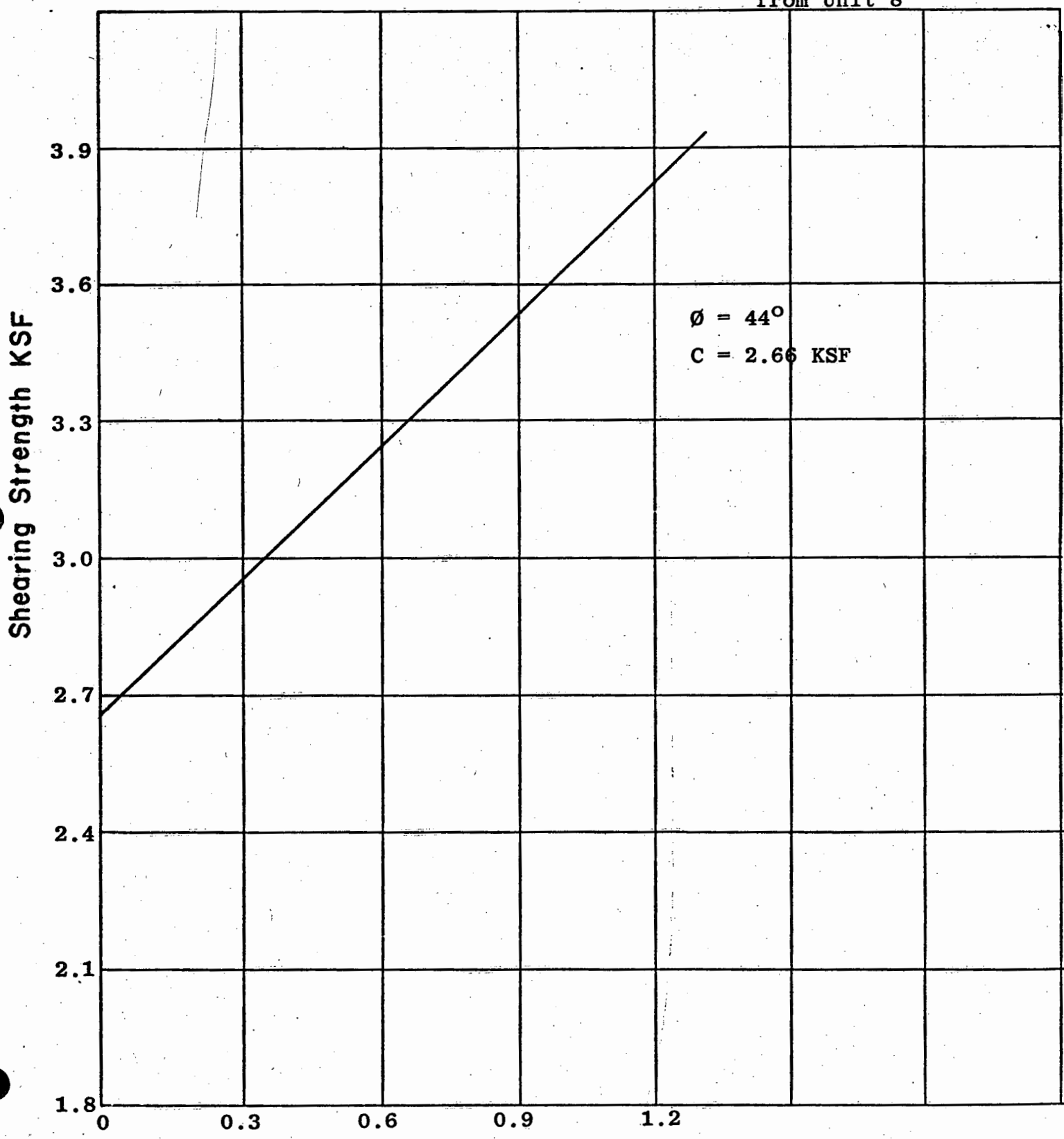



Plate C2

# ERNEST K. HIRATA & ASSOC.

Date 6-3-72

Job Kaopa Storm Water Storage Basin W.O. 139

## SHEAR TEST DIAGRAM

REMOLDED
Mixture of clay and silty clay

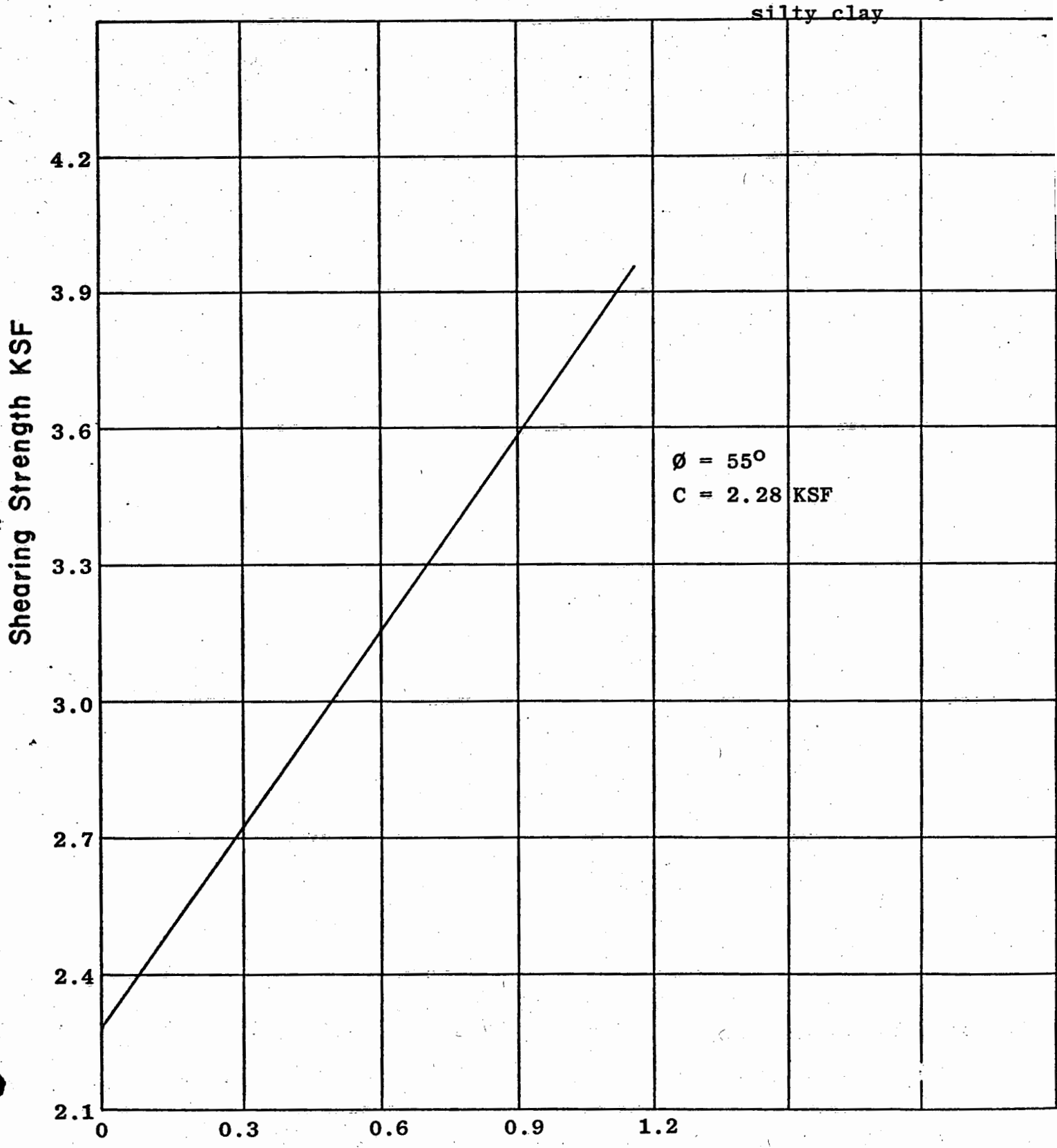



Plate C3